SB761
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85-6

FOREST PEST MANAGEMENT

United States
Department of
Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

3430 BIOLOGICAL EVALUATION
R2-85-6

WESTERN SPRUCE BUDWORM IN THE ROCKY MOUNTAIN REGION

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ABSTRACT

In 1985, results of aerial and ground surveys showed that approximately 1.6 million acres of forest were visibly defoliated by the western spruce budworm in Colorado and 20 thousand acres were visibly defoliated in Wyoming. Defoliation intensity was moderate to severe throughout most of the region.

For the 1985 budworm egg mass survey, 1,592 branches were collected from 52 sites throughout the outbreak area. Survey results indicate that egg mass densities have significantly declined from 1984 levels and light defoliation is expected throughout most of the outbreak area in 1986.

TECHNICAL INFORMATION

Insect: Western spruce budworm, Choristoneura occidentalis Freeman

Hosts: Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea, pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History: The western spruce budworm completes one generation each year.

State	Time	Location on Host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Larger larvae	June	On buds, strobile, and foliage
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation

1. Presence of partially eaten foliage.
2. Mature larvae feeding on current year's needles.
3. Current year's shoots webbed together by larvae.
4. Defoliation most evident in upper crowns of trees.
5. Trees dying from the top downward after several years of heavy defoliation.

EXTENT OF THE OUTBREAK

In 1985, surveys indicated approximately 1.6 million acres were visibly defoliated in the Rocky Mountain Region (Figure 1). Defoliated acreage in the Region is displayed in Table 1.

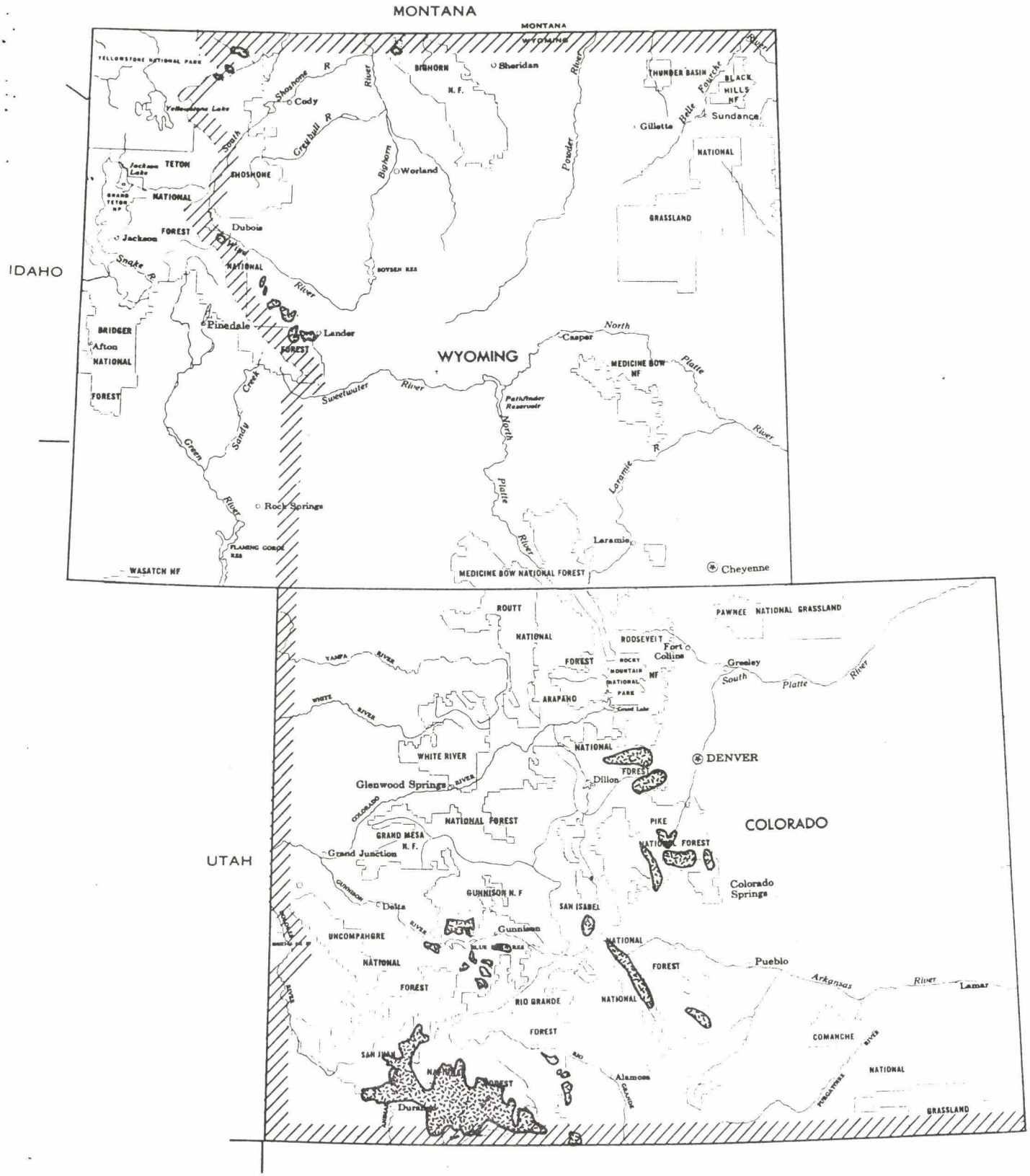


Figure 1. Visible defoliation by the western spruce budworm in the Rocky Mountain Region.

Table 1. 1985 Western Spruce Budworm Defoliation Acreage by Land Ownership Class.[1/]

Area	Land Ownership Class				
	National Forest	Other Federal	State	Private	Total
Arapaho	21,360	3,117	1,355	42,339	68,171
Bighorn	1,536	0	0	42	1,578
Grand Mesa, Uncompahgre & Gunnison	49,915	0	362	4,433	54,710
Pike	126,936	1,764	3,793	89,291	221,784
Rio Grande	17,107	0	0	0	17,107
San Isabel	89,737	9,580	0	54,841	154,158
San Juan	663,481	142,190	8,466	237,011	1,051,148
Shoshone	10,733	10,042	0	71	20,846
TOTAL	980,805	166,693	13,976	428,028	1,589,502

1/ Acreage infested by budworm was determined from aerial sketch maps and ground surveys. For areas that were ground surveyed in 1985, the 1984 defoliation map was used as a base map. If surveys within the 1984 defoliated area showed that visible defoliation had not occurred in 1985, then that survey area was deleted from the base map. Conversely, if ground surveys outside the 1984 defoliated area showed that visible defoliation had occurred in 1985, then that survey area was added to the base map.

EVALUATION METHODS

Egg mass density is used to monitor and predict spruce budworm population trends, evaluate long term effects of control projects and to forecast defoliation. Annual defoliation predictions are based on the density of new egg masses on branch samples collected from the midcrown of host trees (Carolin and Coulter, 1959, 1972).

Egg mass density and defoliation surveys were made during August and September after the egg deposition period. This year, 1,592 branch samples were collected from 240 plots at 52 sites throughout the outbreak area. The locations of these sites are listed in Table 2.

Each plot consisted of six dominant or co-dominant host trees within close proximity. Only trees of one species were sampled at each plot. One 27-inch branch was pruned from the midcrown of each tree for a total of six branches per plot. The foliage samples were bagged, labeled, and transported to the laboratory, where new egg mass densities were determined. A microscope was used to separate new from old egg masses.

Egg mass density classes and associated defoliation are displayed in Table 3. These classes are adopted from McKnight et al. (1970) and were refined by Linnane (1978) based on four years of data from the fixed plot, cluster tree, sampling scheme.

Table 2. Locations of 1985 Western Spruce Budworm Sampling Plots.

National Forest	Plot	Location
Arapaho	Idaho Springs	T.4S., R.73W., Sec.10,11
	Sprucedale	T.5S., R.71W., Sec. 20
GM, Unc.,& Gunnison	Amphitheater CG	T.44N., R.7W., Sec. 32
	Commissary CG	T.50N., R.2W., Sec. 19
	Powderhorn	T.46N., R.3W., Sec. 1
	Sapinero Mesa	T.47N., R.3W., Sec. 23
	Soap Creek	T.50N., R.4W., Sec. 32
Pike	Bergen Rock	T.9S., R.68W., Sec. 6
	Currant Creek	T.15S., R.73W., Sec. 15
	Garber Creek So. 1	T.8S., R.69W., Sec. 25
	Garber Creek So. 2	T.8S., R.69W., Sec. 36
	Indian Creek	T.8S., R.70W., Sec. 10, 14
		T.8S., R.70W., Sec. 19
	Little Scraggy	T.8S., R.71W., Sec. 24
	Ormes Peak	T.13S., R.68W., Sec. 1, 2
Rio Grande	Beaver Creek	T.38N., R.3E., Sec. 11
	Del Norte Peak	T.39N., R.4E., Sec. 8
	Elkhorn Mtn.	T.47N., R.7E., Sec. 24
	Embargo Creek	T.41N., R.4E., Sec. 19
	Massey Gulch	T.33N., R.6E., Sec. 36
Roosevelt	Big Elk Meadows	T.3N., R.72W., Sec. 1, 11
		T.4N., R.72W., Sec. 36
	Devil's Gulch	T.5N., R.72W., Sec. 4
	Magnolia Road	T.1S., R.71W., Sec. 5, 8
San Isabel	Alvarado CG	T.23S., R.73W., Sec. 5
	Balman Reservoir	T.46N., R.12E., Sec. 6
	Buelah	T.23S., R.68W., Sec. 28, 29
	Cucharas	T.31S., R.69W., Sec. 17
	Oak Creek CG	T.20S., R.70W., Sec. 19
	Ophir CG	T.23S., R.69W., Sec. 9
San Juan	Blanco Basin	T.35N., R.2E., Sec. 30
	Cimarrona CG	T.38N., R.3W., Sec. 8
	Columbine Lake	T.39N., R.8W., Sec. 31
	Coon Creek	T.37N., R.8W., Sec. 33
	East Fork	T.36N., R.1E., Sec. 7
	Halfway Canyon	T.33N., R.1W., Sec. 3
	Haviland Lake	T.38N., R.9W., Sec. 25
	Little Sand Creek	T.38N., R.4W., Sec. 27
	Missionary Ridge	T.37N., R.8W., Sec. 34
	Old Timer's CG	T.36N., R.6W., Sec. 20

NATIONAL FOREST	PLOT	LOCATION
San Juan (Continued)	Pine River CG	T.37N., R.6W., Sec. 26
	Poison Park	T.38N., R.3W., Sec. 15
	Transfer Park CG	T.37N., R.7W., Sec. 19
	Vallecito Reservoir	T.37N., R.6W., Sec. 16
		T.36N., R.6W., Sec. 8
	Wolf Creek CG	T.37N., R.1E., Sec. 16
Shoshone	Badger Spring	T.56N., R.105W., Sec. 24
	Dead Indian Creek	T.55N., R.104W., Sec. 16
	Hunter Peak CG	T.57N., R.106W., Sec. 21
	Reef Creek	T.56N., R.106W., Sec. 1, 11, 14
	Sinks Canyon	T.32N., R.101W., Sec. 24, 28

Table 3. Defoliation Prediction Classes for Western Spruce Budworm Egg Mass Sampling in Region 2.

Mean Number of New Egg Masses per Square Meter Foliage	Defoliation Prediction 1/
1.6 or less	Undetectable
1.7 to 10.0	Light
>10.0	Moderate to Severe

1/ Defoliation expected on new growth only

Undetectable	0 - 10%
Light	10 - 35%
Moderate to Severe	>35%

Estimates of current year defoliation levels were made from the egg mass sample branches. For each sampling site, the new growth on 25 randomly selected twigs was examined in the laboratory to determine the percentage of defoliation. Defoliation estimates are based on the percent of missing needles determined by an ocular examination of each twig.

RESULTS

Arapaho National Forest

Approximately 68,171 acres were visibly damaged on National Forest and adjacent lands in 1985. The area of detectable defoliation remained about the same as the 1984 estimate. Data from branch samples indicate the area suffered moderate to severe defoliation in 1985 and that moderate to severe defoliation can be expected again in 1986. (Table 4).

Table 4. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the Arapaho National Forest in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of new growth) 1985	1986 Forecast
Idaho Springs	30	17.8	16.8	49	>35
Sprucedale	30	37.9	13.4	46	>35
SUMMARY		27.9	15.1	48	

Bighorn National Forest

Approximately 1,600 acres of moderate to severe defoliation were detected during our aerial survey in 1985. No egg mass surveys were scheduled on the Bighorn NF.

Grand Mesa, Uncompahgre, and Gunnison National Forests

About 54,710 acres were severely defoliated on National Forest and adjacent lands in 1985. Moderate to severe defoliation is expected in 1986. Egg mass and defoliation data is presented in Table 5.

Table 5. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the Grand Mesa, Uncompahgre, and Gunnison National Forests in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of New Growth) 1985	1986 Forecast
Amphitheater CG	120	16.7	10.6	74	>35
Commissary CG	30	28.2	15.6	90	>35
Powderhorn	30	52.2	18.2	90	>35
Sapinero Mesa	30	38.0	14.7	79	>35
Soap Creek	30	10.5	9.9	91	10-35
SUMMARY		29.1	13.8	85	

Pike National Forest

Aerial and ground surveys indicated that approximately 221,784 acres were defoliated in 1985 on the Pike National Forest and adjacent lands. This represents a 19 percent decline from the 1984 estimate of visible defoliation and a 76 percent decline from the 1983 estimate.

Five new sampling sites were added to our survey in the Pike area. The new sites are Bergen Rock, Garber Creek South #1, Garber Creek South #2, Middle Garber Creek and Rampart/507 Junction. In 1985, defoliation at the sampling sites ranged from 32 to 68 percent. Light defoliation is expected at most of the sites in 1986 (Table 6).

Table 6. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the Pike National Forest in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of New Growth) 1985	1986 Forecast
Bergen Rock	30	Not Sampled	7.2	39	10-35
Currant Creek	30	68.5	47.1	68	>35
Garber Creek So. #1	30	Not Sampled	2.9	40	10-35
Garber Creek So. #2	30	Not Sampled	6.9	32	10-35
Indian Creek	30	14.0	8.7	45	10-35
Little Scraggy	30	65.2	38.0	45	>35
Middle Garber Creek	30	Not Sampled	9.2	36	10-35
Ormes Peak	30	44.8	6.6	38	10-35
Rampart/507 Jct.	30	Not Sampled	5.1	40	10-35
SUMMARY		48.1	14.6	43	

Rio Grande National Forest

Approximately 17,000 acres were visibly defoliated on National Forest and adjacent lands in 1985. This represents a 73 percent decline from the defoliated area reported in 1984.

The area suffered moderate to severe defoliation in 1985. Moderate to severe defoliation is expected again in 1986 at all areas except Massey Gulch. Light defoliation is expected at Massey Gulch next year (Table 7).

Table 7. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the Rio Grande National Forest in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of New Growth) 1985	1986 Forecast
Beaver Creek	30	19.6	14.8	66	>35
Del Norte Peak	30	55.3	14.4	77	>35
Elkhorn Mtn.	30	Not Sampled	25.1	60	>35
Embargo Creek	30	10.7	17.7	76	>35
Massey Gulch	30	Not Sampled	9.4	83	10-35
SUMMARY		28.5	16.3	72	

Roosevelt National Forest

Three areas were sampled. Survey results are presented in Table 8. No visible defoliation was detected on National Forest or adjacent lands.

Table 8. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the Roosevelt National Forest in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of new Growth) 1985	1986 Forecast
Big Elk Meadows	29	9.6	.7	27	1-10
Devil's Gulch	30	7.0	.6	34	1-10
Magnolia Road	30	17.6	11.8	45	>35
SUMMARY		11.4	4.4	35	

San Isabel National Forest

Visible defoliation occurred on 154,158 acres. This is 36 percent less than the defoliated area reported in 1984. Results of the egg mass and defoliation survey of the area are displayed in Table 9.

Defoliation ranged from 29 percent at Alvarado Campground to 68 percent at Cucharas Ski Area.

Table 9. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the San Isabel National Forest in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of New Growth) 1985	1986(Forecast)
Alvarado CG	30	2.1	6.4	29	10-35
Balman Reservoir	30	19.3	14.7	49	>35
Beulah	30	24.3	6.3	42	10-35
Cucharas Ski Area	30	Not Sampled	6.3	68	10-35
Cucharas Proposed Ski Area	42	Not Sampled	6.8	47	1-10
Oak Creek CG	30	23.5	12.4	48	>35
Ophir Creek	30	16.0	4.3	32	10-35
SUMMARY		17.0	8.2	45	

San Juan National Forest

The defoliated area on the San Juan National Forest and adjacent lands decreased to just over 1 million acres this year from 1.2 million acres in 1984. Most of the sampling sites experienced moderate to severe defoliation.

Light defoliation is expected at all sites except Blanco Basin, Columbine Lake, Pine River Campground and Wolf Creek Campground. These four areas are expected to experience moderate to severe defoliation in 1986 (Table 10).

Table 10. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the San Juan National Forest in 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of New Growth) 1985	1986 Forecast
Blanco Basin	30	12.1	14.8	72	>35
Cimmarrona CG	30	14.4	6.8	85	10-35
Columbine Lake	30	13.1	16.8	87	>35
Coon Creek	30	12.7	8.7	41	10-35
East Fork	29	31.2	6.2	75	10-35
Halfway Canyon	30	5.0	2.4	35	10-35
Haviland Lake	30	23.6	2.4	41	10-35
Little Sand Creek	30	13.4	3.0	48	10-35
Missionary Ridge	30	8.9	6.8	59	10-35
Old Timer's CG	22	13.9	1.8	15	10-35
Pine River CG	30	7.3	13.7	66	>35
Poison Park	30	16.2	5.2	60	10-35
Transfer Park CG	30	Not Sampled	6.6	74	10-35
Vallecito Reservoir	30	25.5	6.1	49	10-35
Wolf Creek CG	30	2.6	13.6	78	>35
SUMMARY		14.3	7.7	59	

Shoshone National Forest

The area of visible defoliation decreased by 84 percent on the Shoshone National Forest and adjacent lands. In 1985, 20,846 acres were visibly defoliated.

Defoliation ranged from 4 percent at Hunter Peak Campground to 55 percent at Dead Indian Creek (Table 11).

Table 11. Results of Western Spruce Budworm Egg Mass and Defoliation Surveys on the Shoshone National Forest In 1984 and 1985.

Plot	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1984	1985	Defoliation (% of New Growth) 1985	1986 Forecast
Badger Spring	30	Not Sampled	3.5	43	10-35
Dead Indian Creek	30	3.5	3.5	55	10-35
Hunter Peak CG	30	5.6	0.0	4	0
Reef Creek	30	10.8	.2	7	1-10
Sinks Canyon	30	Not Sampled	21.9	41	>35
SUMMARY		6.6	5.8	30	

SUMMARY

Figure 2 illustrates changes in the area of detectable defoliation from 1979 to 1985 in the Rocky Mountain Region.

Between 1984 and 1985, the area of detectable defoliation in the Region decreased by about 27 percent (Table 12). Significant decreases occurred on the San Juan, Shoshone, and Roosevelt areas where the area of detectable defoliation declined by 179,508; 112,154; and 179,508 acres respectively. The Bighorn was the only area to experience an increase in the extent of visible defoliation.

Figures 3A-3H illustrate changes in egg mass densities for each Forest from 1979 to 1985. Egg mass densities declined significantly from 1984 levels at almost every sampling site. Egg mass densities decreased by 44 percent in the Region. The most significant decreases occurred on the Pike, Roosevelt, and San Isabel areas where egg mass densities declined by 70, 61, and 56 percent respectively.

Light defoliation is expected throughout most of the Region in 1986.

Table 12. Acres of Western Spruce Budworm Defoliation in Region 2,[1] 1981-1985.

Forest	1981	1982	1983	1984	1985
Arapaho	192,000	35,491	151,480	68,191	68,171
Bighorn	0	0	0	0	1,578
Gunnison	120,455	113,007	56,478	70,125	54,710
Medicine Bow	0	0	0	374	0
Pike	663,000	669,698	915,095	274,350	221,784
Rio Grande	0	0	20,458	64,066	17,107
Roosevelt	366,000	419,559	468,760	110,450	0
San Isabel	122,000	82,538	139,450	241,646	154,158
San Juan	570,000	500,834	865,318	1,230,656	1,051,148
Shoshone	130,000	182,054	133,372	133,000	20,846
White River	0	0	0	315	0
Total	2,163,455	2,003,181	2,750,411	2,193,173	1,589,502

[1] Acreage defoliated by budworm was determined from aerial and ground surveys made at the time of peak defoliation.

ALTERNATIVE ACTIONS

An environmental assessment (EA), prepared in 1982, presented alternative strategies for dealing with the current western spruce budworm outbreak in the Rocky Mountain Region and the environmental consequences of those strategies (USDA Forest Service, 1982). The EA identified separate sets of alternatives for undeveloped forest lands and developed forest lands (Appendix A).

The recommendations and assumptions made in the 1982 EA continue to be valid.

FIG. 2 AREA DEFOLIATED BY WESTERN SPRUCE BUDWORM IN THE ROCKY MOUNTAIN REGION, 1979-1985.

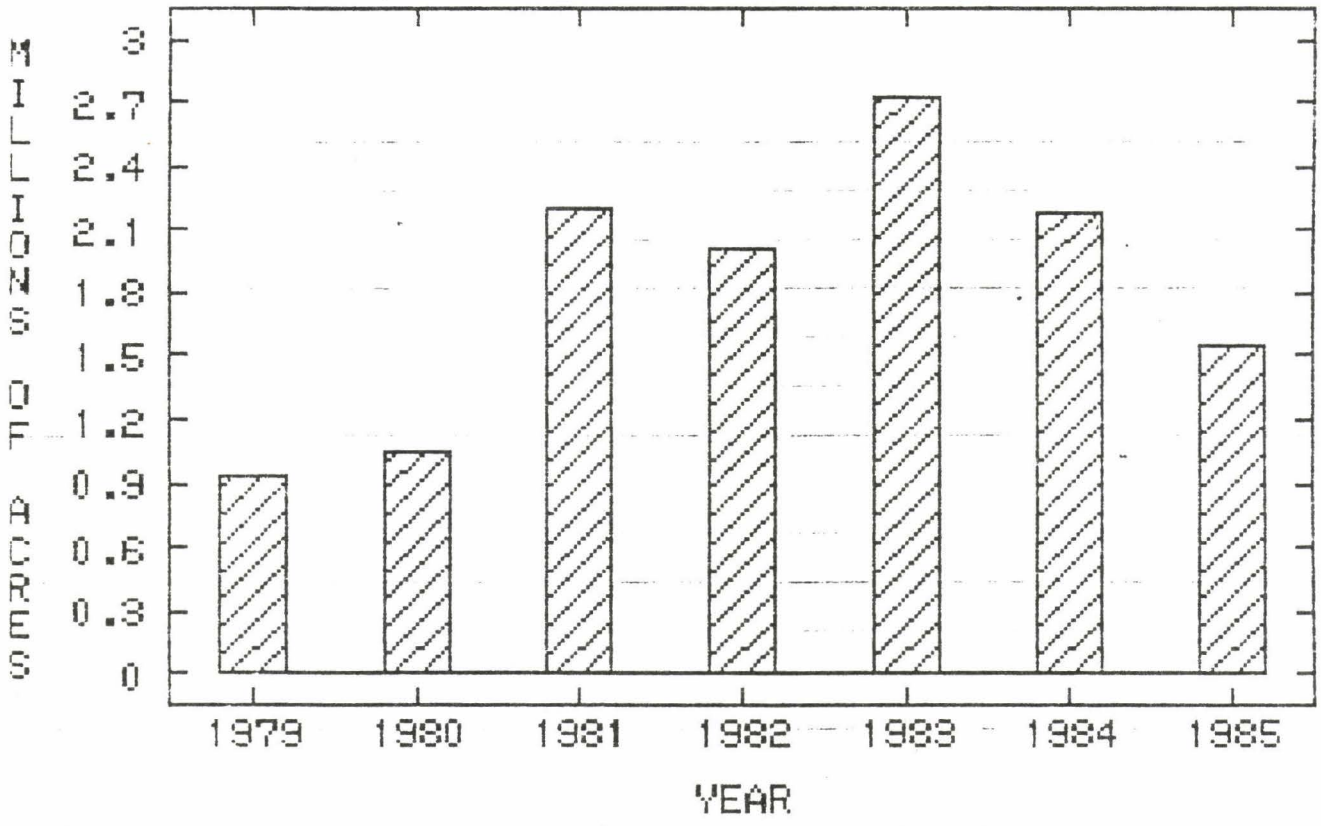


FIG.3A. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ON THE ARAPAHO NATIONAL FOREST, 1979-1985.

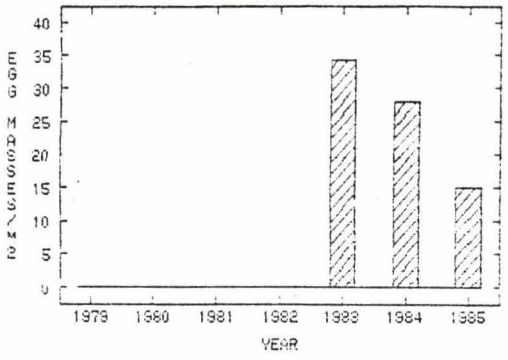


FIG.3B. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ON THE GUNNISON NATIONAL FOREST, 1979-1985.

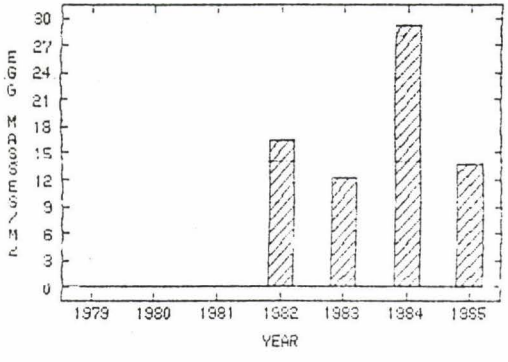


FIG.3C. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ON THE PIKE NATIONAL FOREST, 1979-1985.

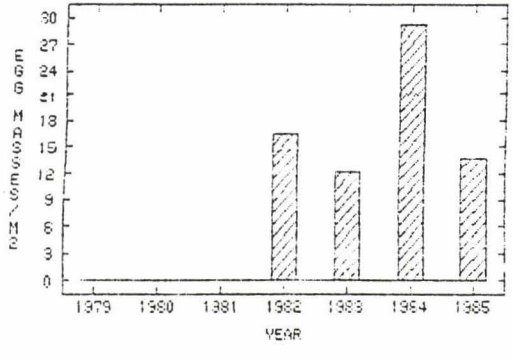


FIG.3D. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES RIO GRANDE NATIONAL FOREST, 1979-1985.

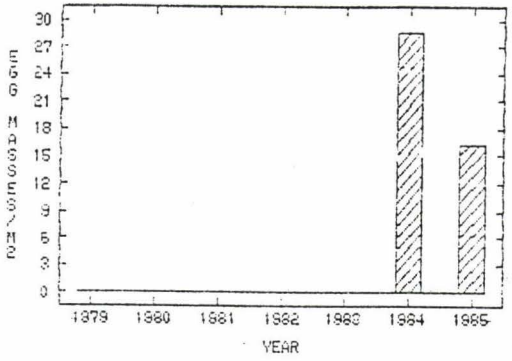


FIG.3E. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ROOSEVELT NATIONAL FOREST, 1979-1985.

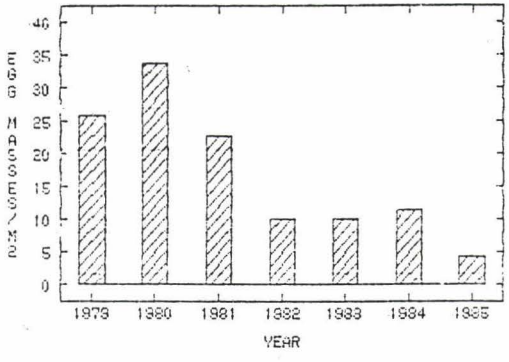


FIG.3F. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ON THE SAN ISABEL NATIONAL FOREST, 1979-1985

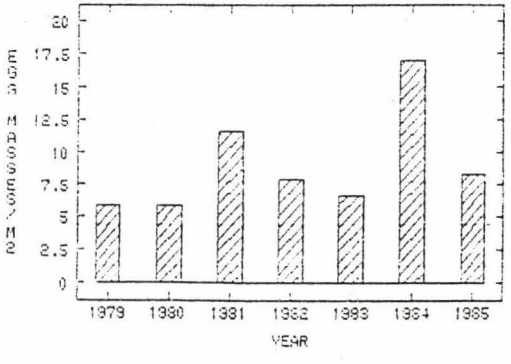


FIG.3G. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ON THE SAN JUAN NATIONAL FOREST, 1979-1985.

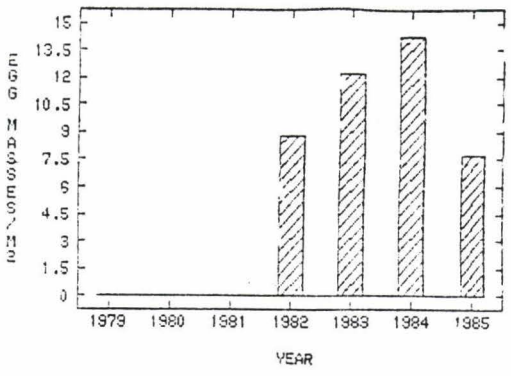
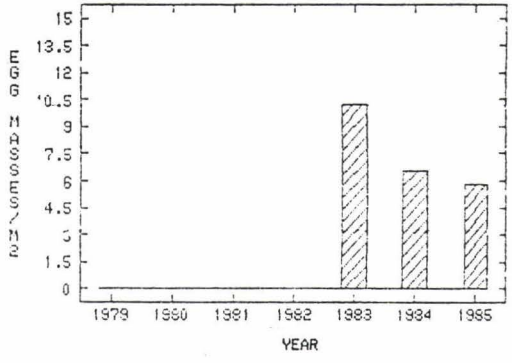


FIG.3H. WESTERN SPRUCE BUDWORM EGG MASS DENSITIES ON THE SHOSHONE NATIONAL FOREST, 1979-1985.



RECOMMENDATIONS

The following actions were recommended in the EA for undeveloped and developed forest lands (Appendix B).

A. Undeveloped Forest Lands

For undeveloped forest lands, the alternative Maintain Current Management is recommended. Although this alternative will result in losses of esthetic and timber values, these losses are judged acceptable based on public opinion, economic evaluation, and current USDA Forest Service policies and objectives.

B. Developed Forest Lands

For developed forest lands, the alternative, Protection of Individual High Value Trees with Insecticides, is recommended because it has little environmental risk, is technically effective, and the least costly suppression strategy.

Forest Supervisors should pay particular attention to developed recreation areas where treament may be warranted. Rationale for these recommendations are found in the 1982 EA.

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